

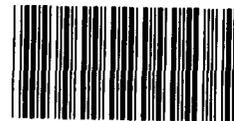
GAO

Report to the Chairman, Legislation
and National Security Subcommittee,
Committee on Government Operations,
House of Representatives

July 1991

ELECTRONIC WARFARE

Faulty Test Equipment Impairs Navy Readiness



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National Security and
International Affairs Division

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July 8, 1991

The Honorable John Conyers, Jr.
Chairman, Legislation and National
Security Subcommittee
Committee on Government Operations
House of Representatives

Dear Mr. Chairman:

This report, which is prepared at the request of your Subcommittee, discusses problems encountered by the Navy in maintaining electronic warfare systems. It recommends that the Secretary of Defense take steps to ensure that the Navy deploys proven test equipment with electronic warfare systems so that they can be effectively maintained.

As arranged with your office, unless you publicly announce this report's contents earlier, we plan no further distribution of it until 30 days from this date. At that time, we will send copies to the Secretaries of Defense and the Navy and to the Director, Office of Management and Budget. Copies will be made available to other interested parties upon request.

Please contact me at (202) 275-4841 if you or your staff have any questions concerning the report. Other major contributors are listed in appendix III.

Sincerely yours,

Louis J. Rodrigues
Director, Command, Control, Communications,
and Intelligence Issues

Executive Summary

Purpose

The Navy equips its tactical aircraft with electronic warfare systems, such as radar warning receivers and jammers, to protect them from hostile weapons. The radar warning receiver alerts the pilot that the aircraft is being tracked by a hostile radar, and the jammer transmits electronic signals to deceive or otherwise interfere with the radar. The Navy believes that these systems are important for the aircraft to be able to accomplish their mission and survive in a wartime environment. Therefore, ensuring that these systems are maintained and operating properly is critical to accomplishing the Navy's mission.

The Chairman, Legislation and National Security Subcommittee, House Committee on Government Operations asked GAO to evaluate the adequacy of test equipment used by the services in maintaining electronic warfare systems. This report, the second in a series, addresses problems identified with Navy systems. In August 1989, we reported on Air Force test equipment inadequacies.¹

Background

To conduct and sustain air combat operations, the Navy should be capable of effectively maintaining its electronic warfare systems. Repairs must be done quickly to meet combat requirements because Navy officials stated that they may require aircraft to fly several combat missions each day. Thus, repairs must be accomplished primarily on the aircraft carrier or at the air station from which the aircraft operate. Because of the technical complexity of the electronic warfare systems, the Navy uses test equipment that is built into the system as well as other sophisticated test equipment to detect system malfunctions and defective components and to verify that systems are operating properly.

Results in Brief

The Navy's capability to conduct sustained air combat with operable electronic warfare systems is degraded because inadequate test equipment used in maintaining the systems precludes timely detection of system defects and hampers verification of combat readiness. This situation stemmed from the Navy's failure to adhere to policies requiring that test equipment be developed and its adequacy verified before electronic warfare systems are deployed. Unless controls over the Navy's acquisition process are strengthened, this situation could recur on newer systems now being acquired.

¹Reliable Equipment Needed to Test Air Force's Electronic Warfare Systems (GAO/NSIAD-89-137, Aug. 11, 1989).

Principal Findings

Test Equipment Is Inadequate

The Navy's test equipment for verifying that electronic warfare systems are functioning properly while installed in aircraft is inadequate. GAO found that much of the equipment was inoperable and because of its lack of reliability and other problems, Navy technicians were not consistently using the equipment as required. In addition, some test equipment needed to maintain the electronic warfare systems for the F/A-18 C and D aircraft does not have components and software necessary for its operation. As a result, Navy maintenance personnel have no effective way to verify electronic warfare system readiness before aircraft missions.

GAO also found that test equipment used in the repair shops aboard aircraft carriers and at Naval air stations was inadequate. This equipment, required to diagnose faulty components and malfunctions, had repeated failures at each location GAO visited, was inoperable for extensive periods in some cases, and lacked the ability to find problems quickly. These inadequacies contributed to repair times that were much longer than allowed to meet combat requirements.

Navy Has Not Complied With Acquisition Policies

GAO found that the Navy had not complied with Department of Defense and Navy policies that stressed the importance of having an adequate maintenance capability for electronic warfare systems. These policies require that needed test equipment be developed and that electronic warfare systems' adequacy be evaluated under realistic operational test conditions before full-rate production and system deployment. Contrary to these policies, the Navy permitted development of test equipment to lag behind development of electronic warfare systems and did not evaluate the adequacy of the test equipment during system operational testing.

Test Equipment for New Navy Jammer Could Be Inadequate

Test equipment for the Navy's new jammer, called the Airborne Self-Protection Jammer, could also be inadequate because the Navy is following the same practices as on earlier system acquisitions.

Recommendations

GAO recommends that the Secretary of Defense ensure that the Navy deploys proven test equipment with electronic warfare systems so that they can be effectively maintained.

Agency Comments

As requested, GAO did not obtain written agency comments on its report. However, GAO discussed its findings with agency officials and included their comments where appropriate.

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Abbreviations

ASPJ	Airborne Self-Protection Jammer
DOD	Department of Defense
GAO	General Accounting Office

Introduction

The Navy acquires electronic warfare systems to protect its aircraft from hostile weapons such as surface-to-air missiles. These systems include radar warning receivers to alert the pilot that the aircraft is being tracked by an enemy radar and jammers to deceive or otherwise interfere with radars used with enemy air defense weapons.

The Navy considers such electronic warfare systems to be essential to the mission capability and survivability of its tactical aircraft. According to Navy guidance, aircraft without properly functioning electronic warfare systems are not considered fully mission capable.

Navy officials stated that they expected tactical aircraft to be capable of performing several combat missions each day. Thus, when electronic warfare systems fail, the problem must be quickly diagnosed and the system restored to an operable status for the next mission. Failure to do so could result in aircraft not being able to perform assigned missions or aircraft attempting missions without the protection offered by the electronic warfare systems.

Navy Maintenance Concept and Equipment Used

The Navy maintains electronic warfare systems at three levels. The first, called the organizational level, refers to maintenance performed while the system is installed in the aircraft. The second, or intermediate level, includes maintenance that must be done in a repair shop on the carrier or at the Naval air station from which the aircraft operate. The third, called the depot level, refers to maintenance beyond the capability of the first two levels and is performed at a central facility located away from the tactical units.

Electronic warfare systems are technically complex. Thus, Navy personnel at each maintenance level use sophisticated test equipment to diagnose system malfunctions, identify faulty system components that must be replaced, and verify that systems are operating properly.

Some of this test equipment is built into the electronic warfare systems. The built-in test equipment is used by pilots and organizational-level maintenance personnel to verify the readiness of systems while they are installed in the aircraft. However, because the built-in test equipment does not perform a comprehensive check of the system, organizational level maintenance personnel also use a portable test set, the USM-406, to verify the integrity of system components.

If checks by the built-in test equipment or portable test set reveal problems, the faulty component is removed and sent to the intermediate-level repair shop. Here, more sophisticated test equipment, called the USM-458, is used to diagnose faults at a more detailed component level.

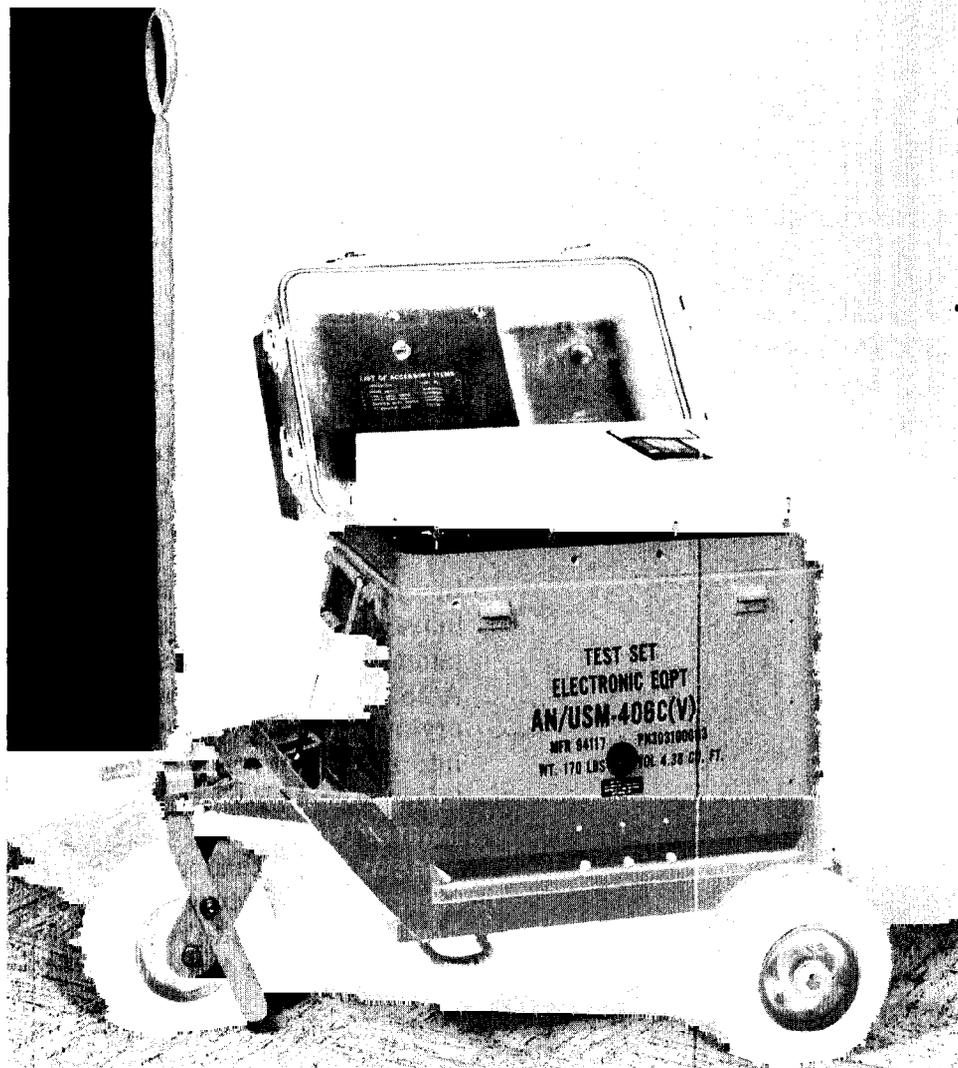
Faulty components that cannot be repaired at the intermediate shop are sent to the depot level. Thus, the Navy's capability to sustain combat operations with proper functioning electronic warfare systems depends primarily on the effectiveness of maintenance at the first two levels.

Objective, Scope, and Methodology

The Chairman of the Legislation and National Security Subcommittee, House Committee on Government Operations, requested that we evaluate the adequacy of test equipment used by the services in maintaining electronic warfare systems. This report, the second in a series, addresses problems identified with Navy systems. In August 1989, we reported on Air Force test equipment inadequacies.

In response to the Chairman's request, we reviewed the test equipment in use or planned for use in maintaining the radar warning receivers and jammers for the Navy's primary tactical aircraft, the A-6E, F-14, and F/A-18. Our review included the USM-406 portable test set used at the organizational level (see fig. 1.1) and the USM-458 test bench used at the intermediate level (see fig. 1.2). This test equipment is used in maintaining the ALR-67 radar warning receiver (see fig. 1.3) and ALQ-126B jammer (see fig. 1.4), which are the Navy's primary electronic warfare systems for tactical aircraft. We also reviewed the acquisition of test equipment for future Navy systems, including the Advanced Special Receiver which is to replace the ALR-67, and the ALQ-165 jammer, commonly called the Airborne Self-Protection Jammer (ASPJ).

Figure 1.1: USM-406 Portable Test Set



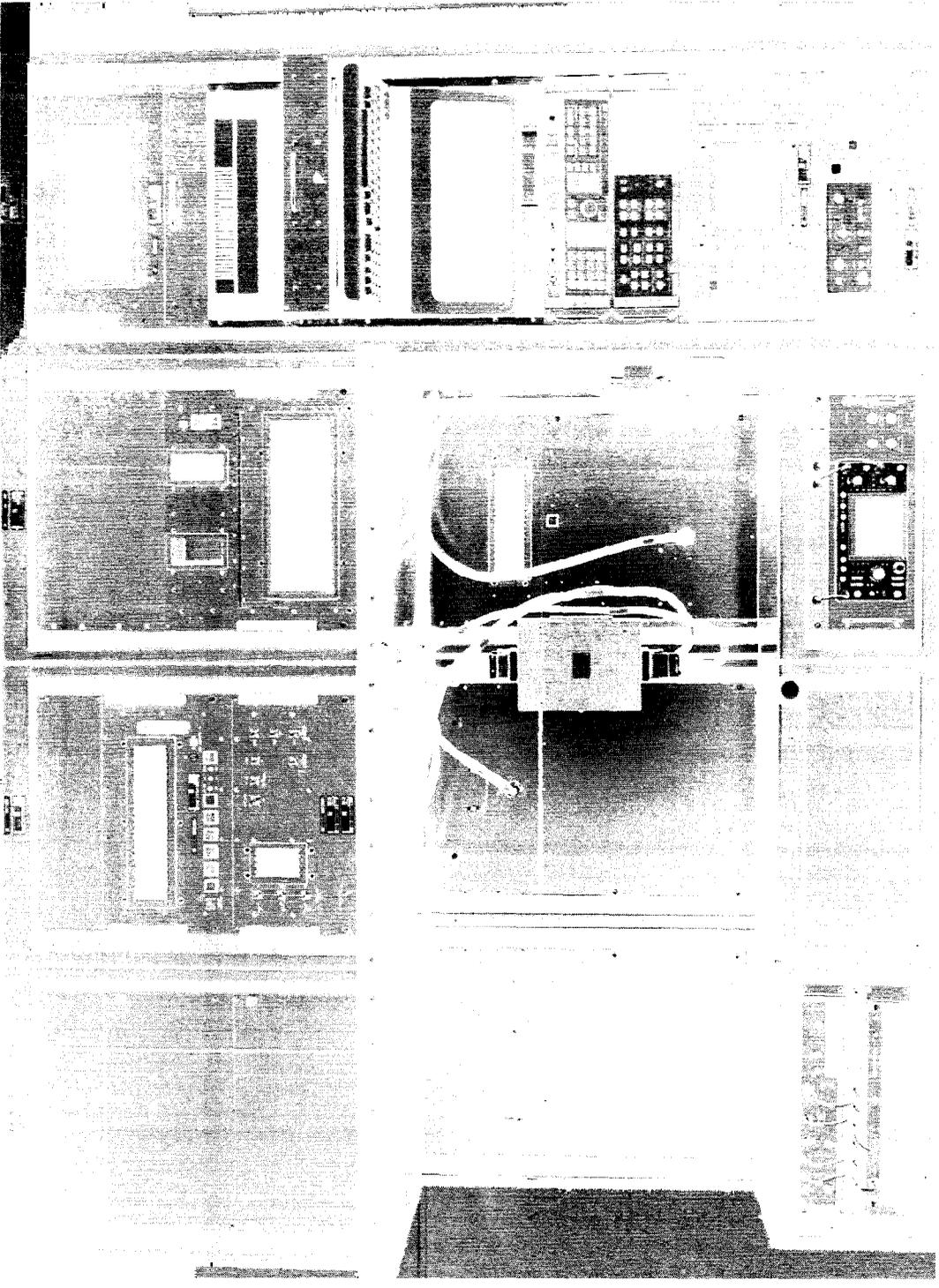


Figure 1.3: ALR-67 Radar Warning Receiver

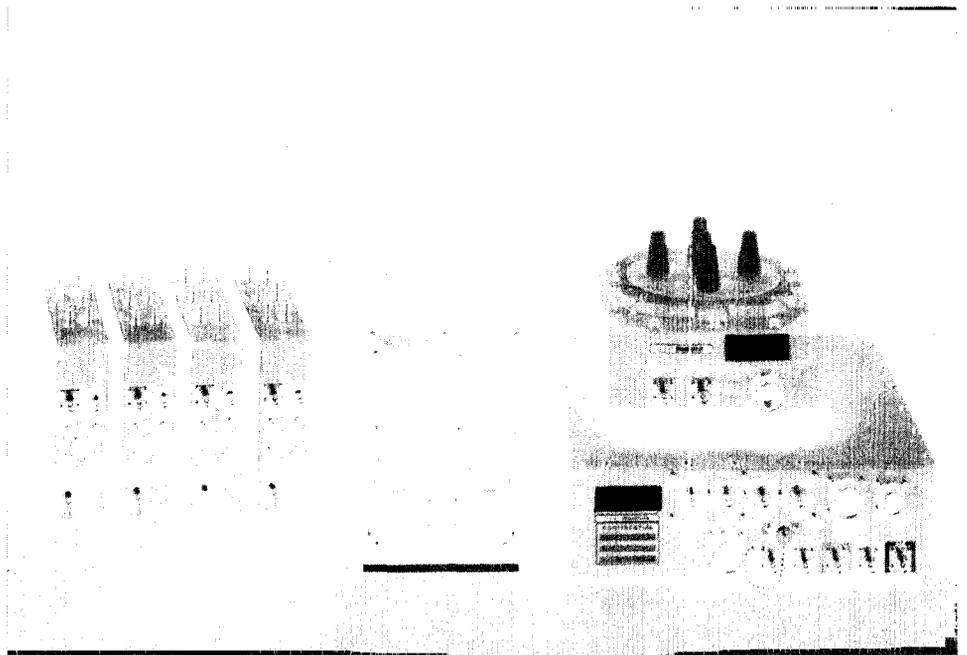
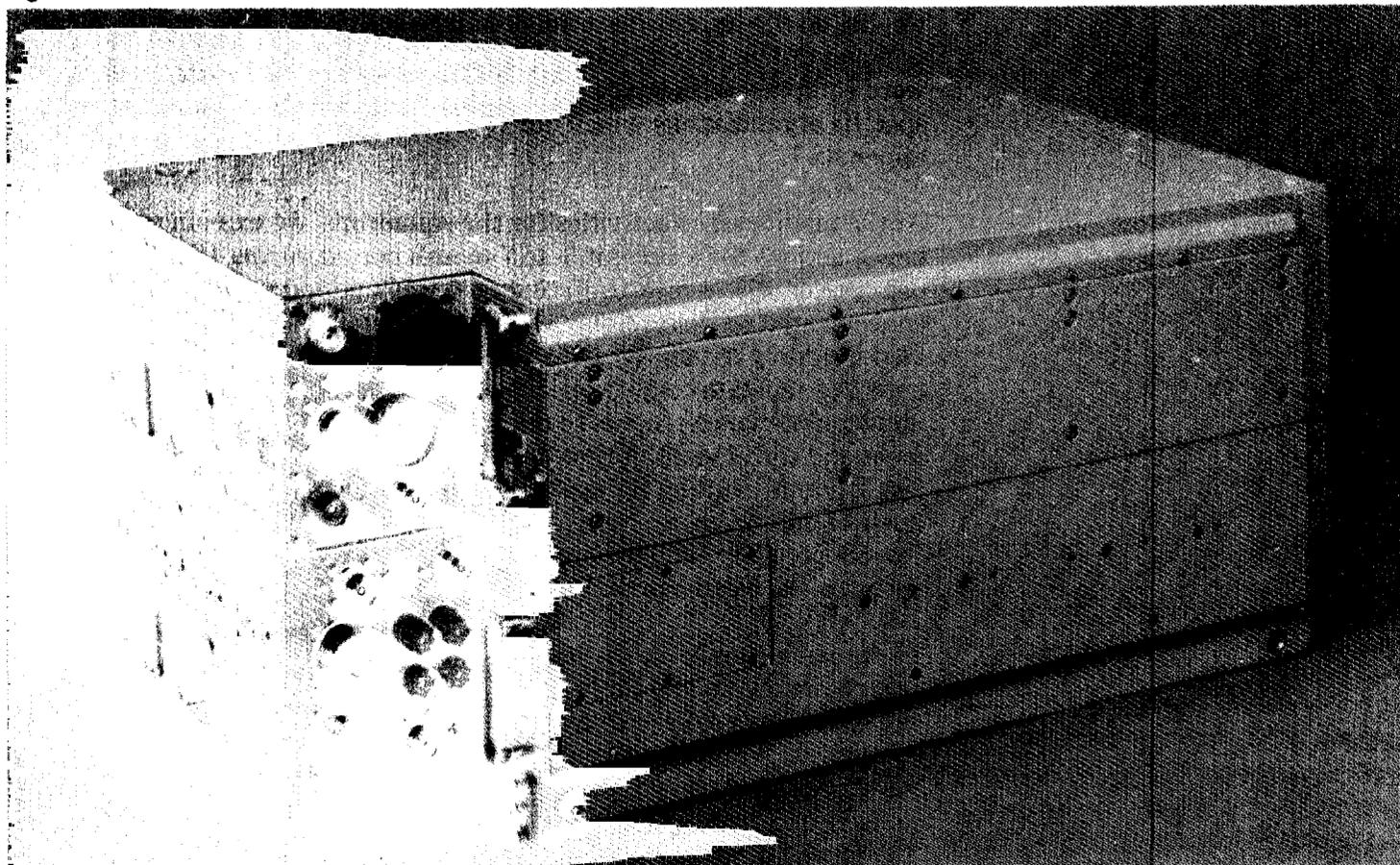


Figure 1.4: ALQ-126B Jammer



We conducted our evaluation at Navy Headquarters and various subordinate organizations responsible for acquiring, testing, and maintaining electronic warfare systems and related test equipment. We reviewed program documents, test reports, acquisition schedules, Navy studies, and other records dealing with the acquisition, test, and maintenance of electronic warfare systems and test equipment and discussed related matters with responsible Navy representatives. We also reviewed Department of Defense (DOD) and Navy policy directives bearing on our objective.

We visited 19 of 53 Navy tactical fighter and attack squadrons equipped with A-6E, F-14, and F/A-18 aircraft. These units were located at three of the four major Naval Air Stations in the United States and aboard two aircraft carriers—one in the South Atlantic prior to its deployment to

the Persian Gulf and the other in port at Norfolk, Virginia. In addition, we visited the intermediate maintenance activity located at each air station and on the aircraft carriers. We selected these units because they were equipped with the Navy's primary electronic warfare systems. The specific organizations where our review was conducted are listed in appendix I.

At the maintenance activities for the squadrons, we examined maintenance actions for a current 5- to 7-month period during 1990 except for one carrier where records for only a 6-week period were available.¹ We concentrated on determining whether the available test equipment enabled the Navy to identify defective systems and repair them quickly enough to sustain combat operations. We accomplished this by examining maintenance records to determine the reliability of the test equipment and the amount of time electronic warfare systems spent in repair less any time waiting for spare parts. We also analyzed Navy-wide maintenance data from the Navy's master data base covering the 19 months from September 1988 through March 1990 to ascertain the repair time spent on the electronic warfare systems.

To supplement our review of the maintenance records, we interviewed unit commanders and Navy maintenance personnel. In addition, we examined Navy-wide surveys dealing with the electronic warfare test equipment. We also observed maintenance actions being performed by Navy personnel using the test equipment discussed in this report.

As requested, we did not obtain official agency comments on this report. However, we discussed our work with responsible Navy officials and have included their comments as appropriate. Our review was performed from August 1990 to March 1991 in accordance with generally accepted government auditing standards.

¹The months varied on the basis of data available at the maintenance activities. All data used were from the period March through November 1990.

Faulty Electronic Warfare Test Equipment Impairs Navy's Combat Readiness

The Navy's capability to conduct and sustain air combat with operable electronic warfare systems has been impaired because of inadequate test equipment used in maintaining the systems. Test equipment at the organizational level is inadequate or has been deployed by the Navy to tactical aircraft units without the components and software necessary for its operation. As a result, some Navy aircraft squadrons cannot fully verify that electronic warfare systems are functional prior to combat missions. Test equipment at the intermediate level is also inadequate and contributes to repair times far in excess of those required to meet combat requirements.

These consequences stemmed from the Navy's failure to adhere to acquisition policies. These policies require that test equipment be developed and its adequacy for maintaining electronic warfare systems be verified during operational tests before electronic warfare systems are fielded. Unless controls over the Navy's system acquisition process are strengthened, this situation could recur on future electronic warfare system acquisitions.

Organizational-Level Test Equipment Is Inadequate

The USM-406 test set is unreliable, not used consistently as required, and in some cases has been deployed to Navy forces without certain components and software required to operate it. As a result, pilots may fly aircraft missions with undetected faults in their electronic warfare systems.

Navy maintenance requirements state that aircraft and associated electronic warfare systems are to be tested on a scheduled basis with the USM-406 test set. Such testing is necessary because the built-in test equipment for electronic warfare systems does not test the systems' transmission lines and antennas that are aboard the aircraft and are essential to the functioning of the electronic warfare systems. Tests identify faults in the systems and the lines and antennas. Navy maintenance personnel told us that in some cases the tests identified faults in the electronic warfare systems that built-in test equipment had failed to detect. Thus, without the use of the USM-406, the Navy has no assurance of the readiness of its electronic warfare systems for combat operations.

USM-406 Test Sets Are Unreliable and Not Consistently Used

The USM-406 test set is frequently inoperable and not used consistently to verify the combat readiness of electronic warfare systems. In June 1990, the Naval Aviation Depot, Jacksonville surveyed the Navy-wide operational status of the USM-406 and found that 64 of 154 test sets, or

42 percent, were inoperable. In addition, an evaluation by the Navy's Pacific Missile Test Center concluded that the reliability of the test set was questionable and seldom used.

At the sites visited, we found that 24 of 71 available test sets were inoperable. Navy technicians told us that in addition to the test set's lack of reliability, other factors also contributed to its lack of use. They said that the test set was very difficult to operate and required excessive time to complete tests of the electronic warfare systems. Even when operable sets were available some technicians conceded that the test sets were not used.

Our observations of the test set in use confirmed the difficulty technicians had in performing the tests. We noted that cables were defective and had to be exchanged and that the test set had difficulty passing its own self tests. Each test attempt required several hours, and a complete test of both the ALQ-126B and ALR-67 installed in the aircraft was not accomplished at that time.

Some USM-406 Test Sets Are Incomplete

The Navy's ability to verify the operation of electronic warfare systems aboard aircraft has also been impaired because of delayed deployment of necessary components and software for the USM-406 test set. In fiscal year 1988, the Navy began fielding F/A-18 C and D aircraft with no capability to validate the readiness of the aircraft's electronic warfare systems. Some USM-406 components and software necessary for the test set's operation were not available. As of September 1990, the Navy had deployed 160 aircraft to 12 squadrons without complete test sets.

In December 1990, over 3 years after first fielding of the aircraft, the Navy began fielding the needed components and software. However, as of March 1991, some F/A-18 C and D aircraft still could not be tested because deployment of the missing components and software had not been completed.

Intermediate Maintenance Test Equipment Is Inadequate

The USM-458 test bench at the intermediate maintenance activities is inadequate because the bench is often completely or partially inoperable and diagnostic software for the bench has limited capability to identify faulty components and malfunctions. As a result, the intermediate maintenance activities are requiring more time to identify and repair faults in the ALR-67 and ALQ-126B than allowed by Navy maintenance standards.

USM-458 Test Bench Is Often Inoperable and Has Limited Capability

The Navy has experienced reliability problems with the USM-458 test bench. Each intermediate maintenance activity we visited had experienced complete or partial failure of the test bench, some for extensive periods of time. For example, one of the two test benches at a shore-based intermediate maintenance activity had been inoperative for 4 months at the time of our visit. Also, according to a Navy official on an aircraft carrier, the USM-458 test bench was totally or partially inoperative for much of the carrier's 6-month deployment to the Mediterranean, which ended in September 1990. The official stated that these problems caused major delays in the repair of electronic warfare systems.

The problem of the USM-458's lack of reliability is compounded by the difficulty in obtaining spare parts to repair it. For example, maintenance technicians at one location we visited stated that the problem of obtaining parts sometimes forced them to resort to removing parts from one test bench to use in repairing another. The technicians had recently removed a major component from one of their two benches in order to repair the other.

Since the test benches fail frequently and spare parts are lacking, it is difficult to maintain electronic warfare systems, particularly those deployed on aircraft carriers that have only one USM-458. For example, two carriers recently deployed to the Middle East for Operation Desert Storm experienced failures of the USM-458 but could not repair the test benches until needed spare parts could be shipped from an intermediate maintenance activity in the United States. In the meantime, repairs to the electronic warfare systems could not be made.

In addition to the problem of the USM-458's reliability, the Navy is experiencing problems with the diagnostic software used on the USM-458 test bench to isolate faults on the ALR-67 and the ALQ-126B. For example, in a September 1990 survey of the diagnostic software for the ALR-67, the Naval Aviation Depot in Jacksonville, Florida found that 9 of 22 intermediate maintenance activities had inoperative software.

Navy technicians at the sites we visited confirmed that the diagnostic software frequently malfunctioned and impeded maintenance activities.

The technicians also informed us that the USM-458's software often did not diagnose electronic warfare system faults to the level needed to identify the problem and enable timely repair. Our review of maintenance records at one site also showed that in 25 of 28 maintenance actions technicians replaced several system components before isolating the fault.¹

Test Equipment Limitations Contribute to Lengthy Repair Times

Navy documents, which describe the repair requirements for electronic warfare systems, state that intermediate maintenance technicians, using the test benches provided, should require an average of 2 hours for the ALQ-126B and 45 minutes for the ALR-67 to correctly identify faults and make needed repairs.² These time constraints are important because spare electronic warfare systems may not be available and the Navy may need its aircraft to fly several combat missions each day. If an aircraft's electronic warfare systems malfunction during a combat mission and spare systems are not available, then repairs must be done quickly to ready the aircraft for its next combat mission.

Table 2.1 shows the average number of days it took for the units we visited to return a system to an operable condition after it was received in the shop for repairs, less any time spent awaiting parts.

Table 2.1: Average Number of Days Required to Return Systems to an Operable Condition

Electronic warfare systems	Number of maintenance actions	Average time (days)
ALQ-126B	157	3.8
ALR-67	129	9.5

Navy-wide data indicate that the repair times are even more excessive. Our analysis of Navy-wide maintenance data for the 19-month period from September 1988 to March 1990 showed that intermediate maintenance activities required an average of 9.8 days for the ALQ-126B and 10.5 days for the ALR-67 to identify faults in these systems and make repairs.

¹Records maintained at other sites were not adequate for this type of analysis.

²DOD officials disagreed with our use of these standards as criteria in evaluating the Navy's maintenance capability. See appendix II.

Improvements Needed in Acquiring Electronic Warfare Test Equipment

DOD and Navy stated policies require that test equipment be developed and its ability to support electronic warfare systems be verified prior to the systems' deployment. Instead of adhering to these policies, the Navy has permitted the development of test equipment to lag behind the related electronic warfare system development and has deployed the electronic warfare systems without verifying their maintainability.

DOD and Navy policies provide that the requirements for test equipment needed to maintain systems be identified early in the acquisition process. In addition, operational effectiveness and suitability of a system must be demonstrated in realistic operational testing before full-rate production and deployment. Demonstrating suitability includes proving that the system can be maintained in an operational environment. Organizational and intermediate level test equipment for the ALQ-126B and ALR-67 had not been developed and operationally tested prior to production decisions. These systems were subsequently deployed without the required test equipment.

Navy officials stated that the delay in developing test equipment to support these electronic warfare systems was caused primarily by the difficulty in developing software before the design of the systems was stable. They stated that if test equipment software is developed too early during the development of the electronic warfare system, it could be rendered obsolete if the system design changes significantly. However, in order to comply with DOD and Navy policies, the design of electronic warfare systems qualifying for the full-rate production and deployment phase should be sufficiently stable to permit completing the development and testing of the test equipment software.

Navy May Experience Maintenance Problems on New Jammer

The Navy is acquiring a new jammer, called the Airborne Self-Protection Jammer (ASPJ), to replace the ALQ-126B. However, during the operational tests, the Navy's Operational Test and Evaluation Force reported the lack of intermediate level test equipment as a major limitation to testing the ASPJ. According to Navy plans, the intermediate-level test equipment will also be unavailable for the operational testing required to support the full-rate production decision on the ASPJ. In addition, the Navy intends to deploy the ASPJ several years before the test equipment software for intermediate level support is available and without demonstrating that the system can be adequately maintained.

Recommendation

We recommend that the Secretary of Defense ensure that the Navy deploys proven test equipment with electronic warfare systems so that they can be effectively maintained.

Department of Defense Organizations Visited

Washington, D.C.

- Office of the Assistant Secretary of Defense for Production and Logistics
- Chief of Naval Operations
- Naval Air Systems Command

Norfolk, Virginia

- Commander, Operational Test and Evaluation Force
- Commander-in-Chief, U.S. Atlantic Fleet
- Naval Air Force, Atlantic Fleet

Virginia Beach, Virginia

- Naval Air Station, Oceana
 - Aircraft Intermediate Maintenance Department
 - Fighter Wing One, Atlantic
 - Squadron VF-33
 - Squadron VF-101
 - Squadron VF-102
 - Squadron VF-103
 - Squadron VF-142
 - Squadron VF-143
 - Medium Attack Wing One, Atlantic
 - Squadron VA-34
 - Squadron VA-42
 - Squadron VA-75
 - Squadron VA-85

Jacksonville, Florida

- Naval Air Station, Cecil Field
 - Aircraft Intermediate Maintenance Department
 - Light Attack Wing One, Atlantic
 - Squadron VFA-82
 - Squadron VFA-86
 - Squadron VFA-106
 - Squadron VFA-131
 - Squadron VFA-132
 - Squadron VFA-136
 - Squadron VFA-137
 - Squadron VFA-203
 - Naval Aviation Depot

Lemoore, California

- Naval Air Station, Lemoore
- Aircraft Intermediate Maintenance Department
- Light Attack Wing, Pacific
- Squadron VFA-125

Point Mugu, California

- Pacific Missile Test Center

Aircraft Carriers

- USS America
- USS Eisenhower

Criteria Used in Evaluating the Navy's Maintenance Capability

Our use of the 45-minute and 2-hour time standards as criteria in evaluating the Navy's maintenance capability was a point of issue with DOD officials. They told us that the standards were intended to apply only to the period that the electronic warfare systems were actually being worked on. They said that no standards had been established for the allowable repair times measured from when the faulty electronic warfare systems were received in the repair shop.

However, measuring only the time that systems were actually being worked on would ignore an inability to repair systems because of such factors as inoperable test equipment. In view of this and because the Navy had established no other standards for better measuring its overall maintenance capability, we used the standards of 45 minutes and 2 hours in our assessment.

While the standards may not be an exact period allowable for repairing electronic warfare systems, they should be an approximate indication of the repair times required to support sustained combat operations. Prompt repairs are necessary because the Navy may require its aircraft to fly several combat missions each day, does not procure sufficient electronic warfare systems to equip all of its aircraft, and would have no spare systems in a large scale conflict. Thus, repair times exceeding a few hours could result in operable electronic warfare systems being unavailable for combat missions. In any event, our use of the 45-minute and 2-hour standards would seem to be a moot issue in view of the actual average repair times of 3.8 days for the ALQ-126B and 9.5 days for the ALR-67 being experienced by the Navy.

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